

**ABSTRACT**

Ion optical methods and apparatus are provided for producing low energy ion beams. The apparatus includes an acceleration electrode for accelerating the ion beam, a deceleration electrode downstream of the acceleration electrode for decelerating the ion beam, and an ion optical element downstream of the deceleration electrode for inhibiting electrons in the beam plasma from reaching the deceleration electrode. The deceleration electrode is biased at a voltage that is selected to provide a potential barrier to thermal ions in the beam plasma to inhibit the thermal ions from reaching the acceleration electrode. The ion optical element maybe implemented as an electron repulsing electrode or as a magnetic element. The acceleration electrode, the deceleration electrode, or both, may be segmented in a direction lateral to the ion beam to define individually controllable electrode segments. The ion optical apparatus may be implemented as an ion source extraction system or as a deceleration lens system.

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